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What is claimed is:

1. An optical switch comprising:

a plurality of optical fibers for use in transmitting optical signals;

a plurality of beam forming devices each having an optical aperture, each of said beam forming devices being optically associated with a corresponding one of said plurality of optical fibers, said fibers and beam forming devices being configured such that each of said beam forming devices can image an optical aperture of a corresponding one of said fibers onto the optical aperture of another one of said beam forming devices corresponding to another one of said fibers;

a plurality of beam directing devices, each of said beam directing devices being optically associated with a corresponding one of said plurality of optical fibers, said beam directing devices being operative to establish an optical connection between a first fiber of said optical fibers and a second of said optical fibers by directing beams from said first fiber to said second fiber and directing beams from said second fiber to said first fiber so as to permit bi-directional communication between said first and second fibers;

said beam directing devices further being operative for establishing said connection between said first and second fibers such that, at an optical aperture of each of said first and second fibers, any angle between an axis of a beam entering or exiting a respective one of said first and second fibers and an axis of said respective one of said first and second fibers, is less than a numerical aperture of said respective one of said first and second fibers.

2. An optical switch as set forth in Claim 1, wherein each of said beam directing devices is a mirror rotatable about at least one axis.

3. An optical switch as set forth in Claim 2, wherein said mirror is embedded in a MEM chip.

4. An optical switch as set forth in Claim 1, wherein said plurality of optical fibers is arranged in an array facing a fixed mirror so as to enable interconnection between any pair of said fibers.

5. An optical switch as set forth in Claim 1, wherein said plurality of optical fibers is arranged in first and second arrays so as to enable interconnection between any fiber of said first array and any fiber of said second array.

6. An optical switch device for directing optical signals between a first input optical fiber end of a plurality of input optical fiber ends and a plurality of output optical fiber ends, said optical switch device comprising:

a plurality of beam directing units, each optically disposed relative to a corresponding one of said plurality of output optical fiber ends for receiving an optical signal transmitted from the first input optical fiber end and directing the optical signal to said corresponding one of said plurality of output fiber ends along an optical pathway having a pathway axis that is in substantial alignment with a fiber axis extending centrally from said corresponding output fiber end.

7. The optical switch device of Claim 6, wherein any angle between said pathway axis and said fiber axis is less than a numerical aperture of an output fiber associated with said corresponding output fiber end.

8. The optical switch device of Claim 6, wherein said beam directing unit comprises:

first reflective means, associated with the first input fiber end, for receiving the optical signal from the first input fiber end and reflecting the optical signal at an angle determined by the orientation of said first reflective means; and

second reflective means, associated with the corresponding one of said output fiber end, for receiving the optical signal reflected by said first reflective means and reflecting the optical signal along an optical pathway having an axis extending between said second reflective means and the corresponding one of said output fiber ends, said second reflective means being oriented such that said axis of said optical pathway is in substantial alignment with said fiber.

9. The optical switch device of Claim 8, wherein said first and second reflective means are mirrors.

10. The optical switch device of Claim 8 wherein said first and second reflective means are positionable in a plurality of orientations.

11. The optical switch device of Claim 8 wherein said first and second reflective means are rotatable about at least one axis of rotation to a plurality of orientations.

12. The optical switch device of Claim 8 further comprising:

first beam forming means, disposed between the first input fiber end and said first reflective means, for forming an optical signal emitted from the first input fiber end into a focused beam optical signal targeted on said first reflective means; and

second beam forming means, disposed between the corresponding one of said output fiber ends and said second reflective means, for receiving the focused beam optical signal from said second reflective means and focusing the focused beam optical signal onto the corresponding one of said output fiber ends.

13. The optical switch device of Claim 8 further comprising:

third reflective means, fixed relative to said first and second reflective means, for receiving the reflected optical signal from said first reflective means and further reflecting the optical signal to said second reflective means.

14. An optical switch device for directing optical signals between a plurality of input and output optical fibers, said optical switch device comprising:

reflective means for reflecting an optical signal incident thereon at an angle determined by the orientation of said reflective means;

a first array of a plurality of said reflective means; and

at least one additional array of a plurality of said reflective means;

wherein, an optical signal emitted from a selected input fiber is directed to a selected output fiber when a combination of a selected one of said reflective means of said first array and a selected one of said reflective means of each said additional array are in respective predetermined orientations.

15. The optical switch device of Claim 14 wherein said reflective means are positionable in a plurality of orientations.

16. The optical switch device of Claim 14 wherein said reflective means are rotatable about at least one axis of rotation to a plurality of orientations.

17. The optical switch device of Claim 14 wherein said reflective means are mirrors.

18. The optical switch device of Claim 14 wherein said reflective means include a pair of orthogonal axes of rotation about which said reflective means are rotatable to a plurality of orientations.

19. The optical switch device of Claim 14 wherein said at least one additional array comprises second, third and fourth arrays of a plurality of said reflective means.

20. The optical switch device of Claim 19 wherein each said reflective means of said first and third arrays include an axis of rotation about which said reflective means of said first and third arrays are rotatable to a plurality of orientations and each said reflective means of said second and fourth arrays include an axis of rotation about which said reflective means of said second and fourth arrays are rotatable to a plurality of orientations, said axes of rotation of said reflective means of said first and third arrays being orthogonal to said axes of rotation of said second and fourth arrays.

21. The optical switch device of Claim 14 further comprising:

beam forming means, associated with each input fiber and disposed between the end of its associated input fiber and said first array, for forming an optical signal emitted

from the end of its associated input fiber into a focused beam optical signal targeted on a corresponding one of said reflective means of said first array; and

beam forming means, associated with each output fiber and disposed between the end of its associated output fiber and a last one of said at least one additional array, for receiving the focused beam optical signal from one of said reflective means of said last one of said at least one additional array corresponding to its associated output fiber and focusing the focused beam optical signal onto the end of its associated output fiber.

22. An optical switch device for directing optical signals between ends of a plurality of optical fibers, said optical switch device comprising:

reflective means for reflecting an optical signal incident thereon at an angle determined by the orientation of said reflective means;

an array of a plurality of said reflective means; and

additional means for reflecting an optical signal between one of said reflective means of said array to a second one of said reflective means of said array;

wherein, when a combination of two of said reflective means of said array are in respective predetermined orientations, an optical signal emitted from an end of one optical fiber is directed to an end of a second optical fiber by said combination.

23. The optical switch device of Claim 22 wherein said reflective means are positionable in a plurality of orientations.

24. The optical switch device of Claim 22 wherein said reflective means are rotatable about at least one axis of rotation to a plurality of orientations.

25. The optical switch device of Claim 22 wherein said reflective means are mirrors.

26. The optical switch device of Claim 22 wherein said reflective means include a pair of orthogonal axes of rotation about which said reflective means are rotatable to a plurality of orientations.

27. The optical switch device of Claim 22 wherein said additional means are a mirror fixed relative to said array.

28. The optical switch device of Claim 22 further comprising:

beam forming means for forming an optical signal into a focused beam associated with each optical fiber and disposed between the end of its associated fiber and said array such that an optical signal emitted from the end of its associated fiber is focused on a corresponding one of said reflective means of said array.

29. An optical switch for directing an optical signal between an first fiber end and a selected second fiber end of a plurality of output fibers, said optical switch comprising: first focusing means, disposed in known spatial relation to the first fiber end, for receiving said optical signal from said input fiber end and forming a focused beam, wherein said focused beam includes rays that converge to create an image of the first fiber on the second focusing means;

second focusing means is imaging the end of the second fiber onto the first focusing means;

beam directing unit, optically disposed relative to said focusing means for receiving said focused beam, for selectivity directing said focused beam relative to said selected second fiber end so as to optically connect said first fiber end and said selected output fiber end for transmission of said optical signal therebetween.

30. The optical switch of Claim 29 further comprising:

second focusing means, disposed in known spatial relation to the selected output fiber end, for receiving said focused beam from said beam directing unit and focusing said focused beam onto the selected output fiber end.

31. The optical switch device of Claim 30 wherein said first focusing means is a first lens having a first surface facing the input fiber end and a second surface facing opposite said first surface of said first lens, and said second focusing means is a second lens having a first surface facing the output fiber end and a second surface facing opposite said first surface of said second lens.

32. The optical switch device of Claim 31 wherein with D representing the effective aperture of said first and second lenses, u representing the distance between said first lens and the input fiber end and the distance between said second lens and the output fiber end, v representing the distance between said first and second lenses, NA representing the numerical aperture of the input and output fiber ends, and f representing the focal length of said first and second lenses, the following equations are satisfied:

$$D = 2\,u \tan(\sin^{-1}(N.A.)) + d$$

$$1/f = 1/v + 1/u$$

$$d/u = D/v$$

when a thin lens approximation is assumed.

33. The optical switch device of Claim 29 wherein said beam directing unit comprises a first reflector and a second reflector.

34. The optical switch device of Claim 33 wherein said reflectors are micro electro mechanical mirrors.

35. The optical switch device of Claim 34 wherein each of said mirrors is rotatable about at least one axis.

36. A method of switching an optical signal between the end of an input fiber and the end of an output fiber, said method comprising:

forming the signal emitted from the input fiber end into a focused beam wherein rays of the optical signal emitted from a point on the input fiber end are directed in a convergent manner;

directing said focused beam towards the end of the output fiber end such that, prior to reaching the output fiber end, said a central axis of said focused beam is substantially aligned with an axis extending centrally from the output fiber end; and

receiving said focused beam on the output fiber end.

37. The method of Claim 36 wherein in said step of forming, a first focused beam forming unit is employed, and in said step of receiving, a second focused beam forming unit is employed, said first and second focused beam forming units being substantially identical and together comprising a symmetrical focused beam unit.

38. The method of Claim 36 wherein in said step of directing, the angle between said central axis of said focused beam and the axis extending centrally from the output fiber end is less than a numerical aperture of said output fiber.

39. The method of Claim 36 wherein in said step of directing, at least two reflectors are employed.